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# EFFECTS OF NATURAL FAULT MOVEMENT ON LAND SUBMERGENCE IN COASTAL LOUISIANA

*Sherwood M. Gagliano, Coastal Environments, Inc.*

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## INTRODUCTION

A vast area of south Louisiana is becoming inundated by waters of the Gulf of Mexico as a result of subsidence of fault bound blocks (Figures 1 and 2). The most prominent and active area of submergence and land loss lies seaward of the Golden Meadow Fault Zone, a series of interconnected cracks extending 130 miles across the land from the west bank of the Mississippi River near Empire, Louisiana to Atchafalaya Bay, extending 35,000 feet below the surface, and studded with massive sub-surface pillars of salt. Between 1930 and 1990, some 618 square miles of land south of the Golden Meadow Fault Zone reverted to open water and the loss continues at comparable rates. This is a fault zone with teeth and it's eating away the edge of the continent.

## TECTONIC PROCESSES

A cause and effect relationship has been established between modern fault movement and the catastrophic land submergence and loss that has occurred in coastal Louisiana during the past century. Fault movement is occurring on deep-seated faults that are part of the regional tectonic framework of the Gulf Coast Salt Dome Basin (Murray 1961, Peel et al. 1995, Gagliano 1999, and others). The tectonic framework is a linked system that has onshore and offshore components (Figures 3 and 4). Primary driving processes of the system, and resulting fault movement, are basin subsidence, rifting, isostatic adjustment, sediment loading, salt movement, and gravity slumping (Gagliano et al. 2003a, 2003b). Secondary processes, which may result in localized subsidence, are sediment compaction, soil de-watering and fluid withdrawal (ground water, hydrocarbons and produced water) (Kuecher et al. 2001, Lopez et al. 1997, Morton et al. 2001, and Morton et al. 2003). There is currently disagreement in the geological literature regarding the primary cause of modern fault movement in the region. Morton et al. (2001, 2003) have concluded that it is induced by oil and gas withdrawal, while others, including the author of this paper, believe that the data indicate that natural processes of compaction and tectonic movement are the primary driving processes.

Fault movement has been occurring on some regional faults for more than 100 million years. Some faults have moved during the Pleistocene Epoch, prehistoric Native American times, historic times and modern decades (Gagliano et al. 2003a, 2003b).

Perhaps, the best evidence of fault movement is the occurrence of an earthquake. Although south Louisiana is generally thought of as an area of low seismic activity, a

number of earthquakes have been recorded. These have been correlated with regional faults (Lopez et al. 1997, Gagliano 2005) (Figure 4). In addition to these local earthquakes, shock waves from earthquakes with remote epicenters (i.e., the Alaskan Earthquake of 1964) have also triggered movement and resulting local earthquakes along some South Louisiana faults (Gagliano 2005)**(**Figure 4).

## NATURAL HAZARD IMPLICATIONS

Figure 1 shows changes to the natural landscape that have resulted from fault movement and subsidence. Fault movement affects surface landforms and infrastructure including ridges, barrier islands, wetlands, flood protection levees, highways, and coastal communities. When accompanied by earthquakes, fault movement effects may include liquefaction, breakup of floating marsh mats and other damage to landforms and human-made structures.

Rates, magnitude and frequency of movement have been determined for some faults. The movement data coupled with a process-response model developed from the research provide the basis for risk analysis.

The findings have important implications for Louisiana's proposed multi-billion dollar coastal restoration program.

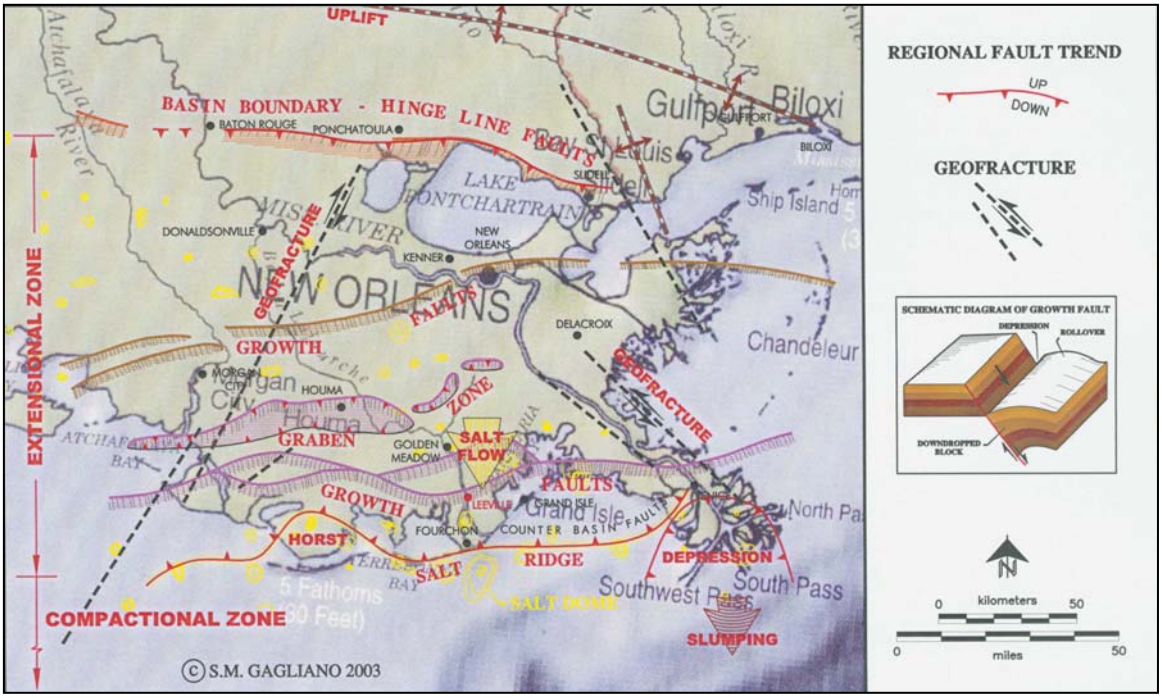



***Figure 1. Map of southeast Louisiana showing major structural features.***

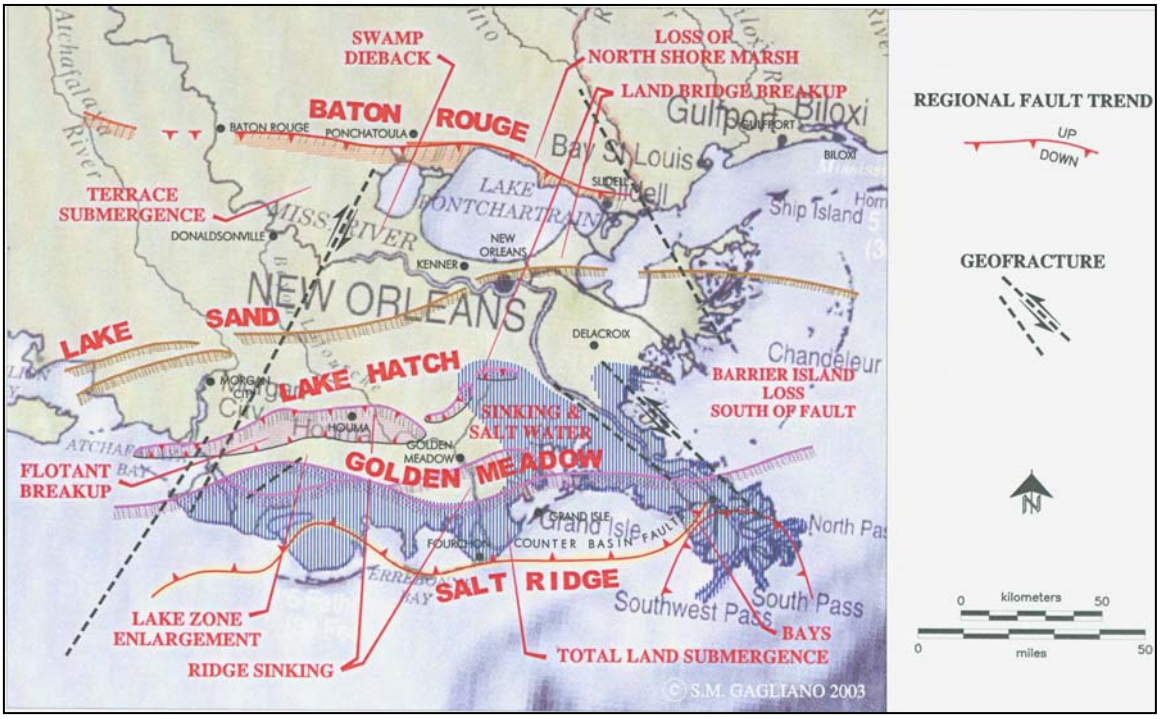
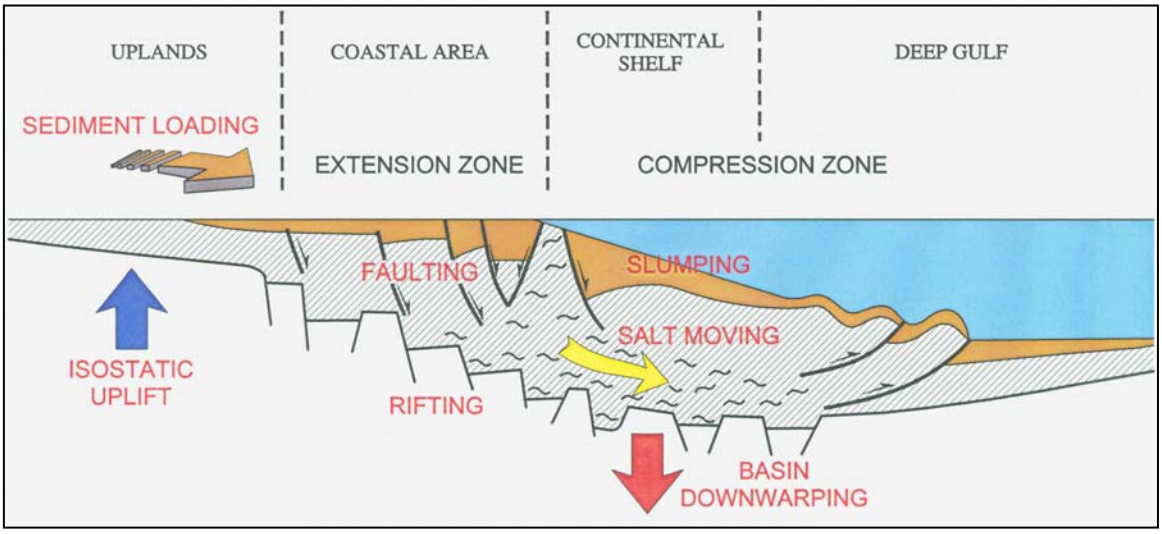



***Figure 2. Landform changes related to fault-induced subsidence in southeast Louisiana.***




***Figures 3. The liked tectonic system under south Louisiana (Eastern Province in Figure 4), part of which extends under the Gulf, resides in a great trough in the earth's crust. The trough fill is riddled with faults and penetrated by salt domes, the movement of which, in relation to overlying sedimentary deposits, affect the surface landscape.***

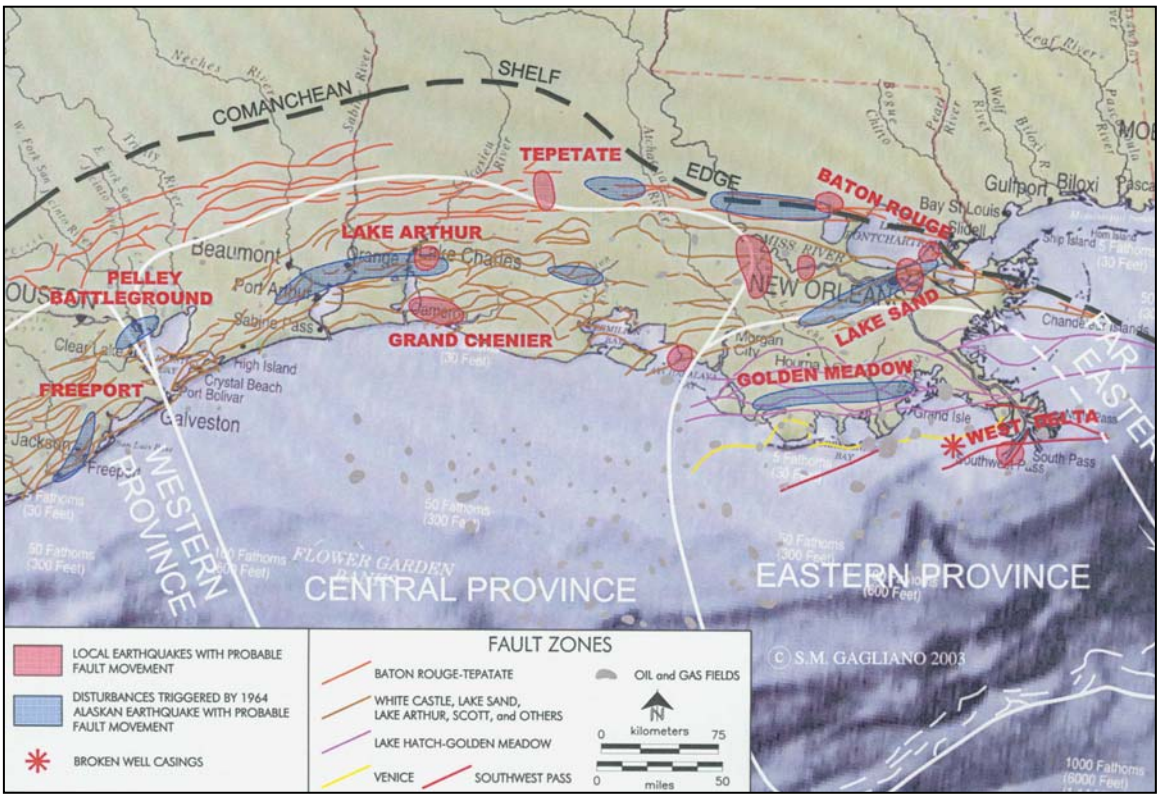



***Figure 4. Map showing major fault zones and locations of reported earthquake effects in south Louisiana and southeastern Texas. Boundaries of liked tectonic systems (provinces) as reported by Peel et al. (1995) are also shown.***

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Sherwood M. Gagliano, Ph.D.
Coastal Environments, Inc.
1260 Main Street
Baton Rouge, LA 70802
Phone: (225) 383-7455
E-mail: *sgagliano@coastalenv.com*